Evaluation of Different Fodder Oats (*Avena sativa* L.) varieties for their herbage mass and seed production potentials in Rasuwa, Nepal

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Abstract

Purpose: Eleven fodder oat (Avena sativa L.) varieties were evaluated for herbage mass and seed production under two cut management system at Pasture and Fodder Research Station (PFRS) Station, Dhunche, Rasuwa for two winter seasons in 2022/23.
Methods: The oat genotypes used were: 1. Sweet oat, 2. Kona, 3. Titan 4. Baler No.1, 5. Monida, 6. Longyan No.2, 7. Everleaf, 8. Longyan No.3, 9. Qingyin No.1, 10. Qinghai 444, 11. Parbati (as a check variety). The experiment was conducted by using a Randomized Complete Block Design (RCBD) with each treatment replicated thrice, each in 6 m2 plot size. The seeds of respective varieties were sown in third week of October. The seed rate, fertilizer and irrigation were applied as per recommendation of NARC. The half of each experimental plot was used for growth and herbage mass evaluation and another half of the plot was left for seed harvest. A total of two harvests was taken to assess herbage mass production. The production parameters viz: plant height, leaf length, leaf breadth, leaf number/tiller, number of tillers/plants, green herbage, dry herbage, fresh straw weight and seed yield were recorded. The collected data were analyzed by using GenStat.
Results: The results showed that the highest cumulative dry herbage (9.7 t/ha) was produced from Qinghai 444 followed by Titan, Kona, Parbati and Longyan No.3 whereas lowest herbage mass was obtained from Baler No.1 $p < 0.01$. Likewise, the average seed yield was 3.3 t/ha which was statistically non-significant among the evaluated oat varieties $p > 0.05$.
Conclusion: Findings of this research thus firmly suggested that there are varietal differences in terms of herbage biomass as well as their seed production potentials of oats varieties; thus these important aspects are worthy to consider while recommending specific varieties to the niche specific regions of Nepal.

Keywords: Dry herbage, Fodder oats, Fresh straw, Green herbage, Seed yield

1 Introduction

The feed deficit in terms of the total digestible nutrients (TDN) is one of the major challenges of livestock production systems in Nepal (Sharma, 2018 and Singh & Singh, 2019). Good quality fodders are the best alternatives to cope with the feed and nutrient deficit situations of Nepalese ruminants (Ghimire et al., 2021). Identifying or developing fodder oat varieties having higher productivity, better quality, and tolerance to abiotic stress is the current need in bridging the gap between demand and supply of green fodder (Ahmad et al, 2015). Accordingly, different species and cultivars of fodder have been continuously introduced in Nepal to overcome the feed deficit, particularly during winter. However, only six such improved varieties of various fodder oats have been released by Nepal Agricultural Research Council for the different agro-ecological regions (Ghimire et al., 2021); leaving space to work further in this line.
Farmers are always in search of promising varieties of fodder oats in terms of quality and quantity production. The insufficiency of good quality seeds of fodder oat is also one of the major limitations of fodder production in Nepal (Singh & Singh, 2019). In this line, oat seed production can be promoted by selecting new varieties having better seed yield as well as fodder biomass potential (Ahmad et al, 2014). Under this context, this research was done with the main objective to assess and evaluate the herbage mass production performance of different oat varieties under two cutting management system (first at 60 DAS and second at flowering stage) and select the potential oat varieties also with respect to seed production potentials, essentially suitable for temperate region of Rasuwa, Nepal.

2 Materials and methods

2.1 Experimental site and duration

Eleven fodder oats (Avena sativa L.) varieties (10 oat genotypes imported from China and 1 Nepalese variety Parbati) were evaluated at Pasture and Fodder Research Station, Dhunche, Rasuwa, Nepal during two seasons (October to May) in 2022 and 2023.

2.2 Oat Varieties used and experimental design

Eleven different varieties of oat along with Parbati (as a check) were used for evaluation. The experiment was done using Randomized Complete Block Design (RCBD) with each variety replicated thrice. The followings are the details of treatments:

Treatments	Varietal description
T1	Sweet oat
T2	Kona
T3	Titan
T4	Baler No.1
T5	Monida
T6	Longyan No.2
T7	Everleaf
T8	Longyan No. 3
T9	Qingyin No. 1
T10	Qinghai 444
T11	Parbati (as a check variety)

2.3 Oat crop management

The experimental plots were ploughed 2-3 times to make fine and friable soil. The size of an experimental plot was of 6 m^2. The varieties were sown on the third week of October. Continuous sowing was done at 0.25 m row to row spacing. The seed was sown at the rate of 100 kg/ha as per recommendation of NARC. The farm yard manure (FYM) was applied at the rate of 10 t/ha and chemical fertilizers: Nitrogen, Phosphorous and Potash (NPK) were applied at the rate of 80:60:40 kg/ha respectively. Full dose of FYM, phosphorus, potash and half dose of nitrogen was applied at the time of final field preparation and the remaining half dose of nitrogen was applied after first harvest. Irrigation was applied at each fifteen days interval. A total of two harvest was taken to assess and evaluate primarily herbage mass production. First harvest was done at 60 days after sowing (DAS) and second harvest was done at 50% flowering stage. The one half of each experimental plot was used for growth and herbage mass estimation and another half of the plot was left for seed production and straw harvest.

2.4 Data collection and statistical analysis

The different data on production parameters viz: plant height, leaf length, leaf breadth, green biomass, dry biomass, fresh straw weight and seed yield were estimated. The morphological characteristics (plant height, leaf length, leaf breadth) were taken from randomly selected five plants from each plot at the time of harvest. The leaf area was calculated by multiplying length with breadth with factor 0.73 (Premi, 2002). All the collected data were processed and analyzed for ANOVA. The statistical software GenStat discovery (18^{th} Edition, VSNi 2015) was used to analyze the data. Mean comparison between the treatments was done using Tukey's test.

3 Results

3.1 Plant height and leaf area

Evaluation of growth attributes of different oat varieties under different harvest dates has been presented in Table 1. Accordingly, the plant height was significant at first harvest $p < 0.01$ and second harvest $p < 0.05$. The highest plant height was obtained from Everleaf at first harvest but the highest plant height was obtained from Qinghai 444 at second harvest. The leaf area was statistically similar $p > 0.05$ among the treatments at both harvest (**Table 1**).

Table 1: Growth attributes (plant height and leaf area) of oat varieties at different harvest in 2022-23, Rasuwa, Nepal

Oat varieties	Plant height, cm		Leaf area, cm^2	
	1st harvest	2nd harvest	1st harvest	2nd harvest
Sweet oat	28.3[a]	101.2[b]	15.4	88.2
Kona	25.9[b]	98.9[b]	16.5	74.7
Titan	24.0[b]	99.9[b]	13.4	93.2
Baler No.1	27.9[a]	76.9[d]	16.4	95.6
Monida	24.5[b]	102.4[b]	14.7	68.6
Longyan No.2	25.5[b]	89.1[c]	14.2	92.3
Everleaf	28.8[a]	95.5[c]	17.3	78.9
Longyan No.3	25.2b	95.0c	15.3	83.9
Qingyin No.1	27.7[a]	99.4[b]	15.3	80.3
Qinghai 444	24.6[b]	119.4[a]	14.8	88.4
Parbati (check)	25.1[b]	99.9[b]	14.9	75.1
Average	26.1	97.9	15.3	83.5
SEM	2.28	8.01	1.57	5.32
CV%	10.6	10.5	11.6	12.4
F probability	<0.01	<0.05	NS	NS

SEM: Standard Error of the Mean, CV: Coefficient of Variation, NS: Non-Significant at p 0.05, Values followed by different letters within a column are significantly different at $p < 0.05$

3.2 Herbage mass production

Green herbage and dry herbage production from different fodder oats treatments under different harvest has been presented in Table 2. Green herbage production was significant $p < 0.01$ at both harvest and also to the cumulative herbage mass production. The highest green herbage was produced from the treatment Longyan No.3 at first harvest and Qinghai 444 produced the highest green herbage at second harvest as well as to the cumulative herbage mass. Similar pattern was obtained in dry herbage mass production (Table 2). Accordingly, dry herbage mass production was significantly different $p < 0.05$ at both harvest as well as in cumulative production $p < 0.01$. As in the case of green herbage mass, the highest dry herbage was produced from the treatment Longyan No.3 at first harvest and Qinghai 444 produced the highest dry herbage at second harvest and in cumulative dry herbage. However, the cumulative dry herbage production by Kona, Titan, Longyan No.3 and Parbati was at par with Qinghai 444.

Table 2: Herbage mass production from fodder oats at different harvest in 2022-23, Rasuwa, Nepal

Oat varieties	Green herbage (t/ha)			Dry herbage (t/ha)		
	1st harvest	2nd harvest	Cumulative	1st harvest	2nd harvest	Cumulative
Sweet oat	6.2[c]	36.1[b]	42.3[c]	1.2[c]	7.5[b]	8.7 [b]
Kona	6.8[c]	38.2[a]	45.0[b]	1.3[c]	8.0 [a]	9.3[a]
Titan	7.2[c]	38.4[a]	45.6[b]	1.3[c]	8.3[a]	9.6[a]
Baler No.1	6.1[c]	24.6[d]	30.6[c]	1.2[c]	4.9[c]	6.1[d]
Monida	8.7[b]	33.1[b]	41.8[c]	1.6[b]	7.2[b]	8.8b
Longyan No.2	7.2[c]	34.1[b]	41.3[c]	1.2[c]	6.9[b]	8.2[c]
Everleaf	9.1[b]	31.0[c]	40.1[c]	1.8[b]	6.2[b]	8.0c
Longyan No.3	11.0[a]	34.0[b]	45.1[b]	2.1[a]	6.8[b]	8.9[ab]
Qingyin No.1	9.2[b]	35.3[b]	44.5[b]	1.5[b]	7.1[b]	8.6[b]
Qinghai 444	8.2[b]	43.2[a]	51.3[a]	1.5[b]	8.2[a]	9.7[a]
Parbati (check)	9.0[b]	38.4[a]	47.3[a]	1.7[b]	7.4[b]	9.1[ab]
Average	8.1	35.1	43.2	1.5 b	7.1 b	8.6
SEM	0.14	1.12	0.89	0.016	0.23	0.54
CV%	8.4	8.6	6.4	10.5	10.4	7.3
F probability	<0.01	<0.01	<0.01	<0.05	<0.05	<0.01

SEM: Standard Error of the Mean, CV: Coefficient of Variation, NS: Non-Significant at p 0.05, Values followed by different letters within a column are significantly different at $p < 0.05$

3.3 Seed and fresh straw production

Table 3 indicates the fresh straw weight and seed yield from different varieties of oat. The seed yield was found non-significant with different varieties of oat. However, the fresh straw mass production at the time of seed harvested time was found significant $p < 0.05$. The significantly highest fresh straw (35.70 t/ha) was obtained from Longyan No.3 followed by Qinghai 444 and Everleaf and that was lowest (12 t/ha) from Baler No. 1 $p < 0.01$. The seed production potential was similar between the tested varieties $p > 0.05$. However, higher seed producing trend was found in Parbati and Everleaf.

Table 3: Fresh straw and seed yield of different varieties of fodder oat in 2022-23, Rasuwa, Nepal

Oat varieties	Seed yield (t/ha)	Fresh straw weight (t/ha)
Sweet oat	3.4	21.4^{b}
Kona	3.2	23.2^{b}
Titan	3.4	22.5^{b}
Baler No. 1	3.3	12.0^{c}
Monida	3.3	24.2^{b}
Longyan No.2	3.4	25.1^{b}
Everleaf	3.5	28.5^{ab}
Longyan No. 3	3.4	35.7^{a}
Qingyin No. 1	3.0	15.3^{c}
Qinghai 444	3.1	32.5^{a}
Parbati (check)	3.5	23.8^{b}
Average	3.3	24.0
SEM	0.12	1.58
CV%	10.8	12.4
F probability	NS	<0.05

SEM: Standard Error of the Mean, CV: Coefficient of Variation, NS: Non-Significant at p 0.05, Values followed by different letters within a column are significantly different at $p < 0.05$

4 Discussion

Growth parameters (plant height and leaf area) affected the green and dry herbage production. Possibly due to variation on growth attributes, the green herbage mass production was differed (Amanullah et al, 2004). Amanullah et al., (2004) reported that higher yields of fodder in oat cultivars can be possibly attributed to their greater leaf area, responsible for more photosynthetic activities having high capacity to store assimilative products of photosynthesis. This situation has been well appeared also in our research. The plant height varied with variety under different environmental condition which was in line with the report of previous researchers (Kibite et al., 2002; Chohan et al., 2004; Buerstmayr et al., 2007). On the other hand, the green herbage production differed with different oat varieties (Shah et al., 2002; Inan et al., 2005; Bilal et al., 2017; Pathan et al., 2007). Bilal et al. (2017) also reported that plant height and number of leaves per plant are major attributes that involved in the forage yield of crop associated with growth and biomass. In agreement to those authors' statement, the tallest variety Qinghai 444 had yielded highest biomass in this research. As observed by Mir et al., (2018), the green as well as dry fodder yield of oat varieties were influenced significantly with their different genetic constituents. Earlier researcher, Kshatri, et al. (1993) also reported that herbage mass production could be varied due to altitudes and location.

The yield limiting factors in forage crops can be divided into several groups: variety efficiency, soil fertility, agro technics and meteorological conditions (Muta et al., 2015). In one recent study, Wangchuk and Wangchuk, (2023) recommended Longyan No.2 and Qingyin No.1 as new oat varieties for fodder production in late winter in the temperate climates of Bhutan. However, these two varieties performed average in our research in temperate climate of Rasuwa, Nepal. Environmental factors and varietal characteristics may both contribute to the variation in morphological traits among oat varieties (Pant et al., 2022; Singh et al., 2018). Hence, the adaptability of different oat varieties to a given environment differs, also due to genetic variations that affect hormonal balance and cell division rate (Zaman et al., 2006).

With respect to the seed performance, there are different research findings, but not so much in the case of Nepal. For example, in Lalitpur district of Nepal, the oat varieties Kona, Titan, Swan Pak and Qingyin No.1 were found better in terms of seed yield (2.87 t/ha) which was at par with the check variety-Netra (Panta et al, 2022). The average seed yield potential of oat genotypes (3.30 t/ha) in this research was found better than that

of previous study by Panta et al. (2022) which might be attributed to genetic makeup of varieties, agronomical practices as well as geographical difference of the study areas. Further concrete research is needed to testify the causes and possibilities to identify varieties most suitable for temperate climatic condition.

5 Conclusion

Findings of this research revealed that the fodder oat genotype Qinghai 444 yielded highest cumulative herbage mass under two cutting management system. Nevertheless, the varieties Titan, Kona, Parbati and Longyan No.3 had at par potential for better dry herbage mass and seed production with Qinghai 444. Therefore, these varieties could be selected as a good herbage and seed producer suitable at the high hill region of Rasuwa, Nepal. Further in-depth research is needed to verify these results under farmer's management condition.

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Conflicts of Interest

The authors have no relevant financial or non-financial interests to disclose.

Authors' Contributions

Dr Bodh Raj Baral: Experimentation, data processing and prepare manuscript of article
Dr. Neena Amatya Gorkhali: Editing manuscript and managing publication process
Mr Birendra Khanal: Project and experiment design, guide to implementation, regular monitoring, providing necessary guidelines for research, data analysis, editing manuscript

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